CLARREO Mission - Earth's Climate Change Observations

The Climate Absolute Radiance and Refractivity Observatory (CLARREO) is a high priority, Tier-1 Decadal Survey mission recommended by the National Research Council. It fills the critical need for unambiguous climate change measurements with an unprecedented level of accuracy. The CLARREO mission will provide a metrology laboratory in orbit for the purpose of accurately quantifying and attributing climate change. The mission also provides the first orbiting radiometers with accuracy sufficient to serve as reference calibration standards for other space sensors, essentially serving as a "NIST in orbit". This will improve the accuracy, by a factor of 5 to 10, and relevance of a wide range of spaceborne instruments for observing Earth's changing climate.

1. Critical Observations of Climate Change:

◇ The climate benchmarks established by CLARREO are critical for assessing changes in the Earth system as society works to meet the challenge of optimizing strategies for mitigating and adapting to climate change. The CLARREO data will be used to test and validate climate models.
◇ CLARREO benchmarks are obtained from direct measurements of the Earth's thermal infrared spectrum, the spectrum of solar radiation reflected by the Earth and its atmosphere, and radio occultation from which accurate temperature profiles are derived.

2. Near Term Impacts:

◇ CLARREO provides the first spectral observations of the far-infrared, which includes 50% of the Earth's energy emitted to space and contains most of the water vapor greenhouse effect.
◇ CLARREO's ability to establish a reference calibration standard for sensors in Earth's orbit will improve weather forecasting and data assimilation, and will improve the accuracy of a wide variety of climate-relevant observations including land processes, atmospheric state variables, aerosols and trace gases, and surface temperature.

3. CLARREO Societal Benefits:

◇ CLARREO provides the data necessary to accelerate decisions on public policy concerning climate change by 15 to 20 years. Earlier and better informed decisions provide a large economic benefit to the U.S. and the world, estimated to be $\sim$ \$12 Trillion over the next 40 to 60 years[1].
◇ By reducing risk in climate prediction, CLARREO will impact U.S. international policy, strategic planning by government agencies (DoD and DoE), operation and sustainment of key national assets (Naval Station Norfolk and Newport News Shipbuilding), and risk assessment by the reinsurance industry.

4. CLARREO Technical Readiness - Ready to Fly!

◇ CLARREO successfully passed its NASA Mission Concept Review in November 2010, with recommendation to proceed to the next stage in development prior to a NASA budget decrease in 2011.
◇ The CLARREO concept is mature and the level of technical risk is low.

5. CLARREO Mission Options:

◇ *CLARREO Spacecraft Flying in 90° Inclination Polar Orbit*: A mission concept with a full suite of instruments, Infrared and Reflected Solar spectrometers and a Radio Occultation sensor, flying on a dedicated spacecraft. Cost estimate $\sim$ \$675M, plus launch vehicle cost.
◇ *CLARREO Flying on the International Space Station*: A mission concept to fly two instruments, Infrared and Reflected Solar spectrometers, on the International Space Station and acquire the radio occultation data from the COSMIC constellations. This option offers the best overall science value for the lowest cost $\sim$ \$400M, launch cost included.

[1]Using the U.S. Interagency Memo of the Social Cost of Carbon (2010), CLARREO's value has been estimated at about \$20 Trillion for a 2.5% discount rate, \$12 Trillion for a 3% discount rate, or \$3 Trillion for a 5% discount rate.